

CA1
YC2
-61M18



3 1761 11972383 1

Canada. Labour dept. Economics
and research branch
[General publications]
[G-4] Technological changes
and their impact on employment and
occupations

ACCOPRESS

GENUINE PRESSBOARD BINDER

CAT. NO. **BD 2507 EMB**

ACCO CANADIAN COMPANY LTD.
TORONTO

OGDENSBURG, N.Y., CHICAGO, LONDON
MEXICO CITY D.F., UTRECHT

CAI
402
-61418

Technological Changes and Their Impact on
Employment and Occupations

Introduction

[General publications]

[6-4] Technological Changes and Their Impact on Employment

and
Occupations

which are occurring in the Canadian economy, and to outline some of their manpower effects. The discussion will be based on the research that has been undertaken to date by the Manpower Resources Division of the Economics and Research Branch of the Department of Labour as part of a broad manpower training research program. Although this research has not been completed, it has thrown some light on two major aspects of technological change:

(1) its general effects on the economy, and (2) its effects on the particular occupations and occupations groups. The report is prepared for the
Special Committee of the Senate of Canada
on Manpower and Employment

by the

Economics and Research Branch,

Department of Labour, Ottawa.

Can.

Work has been done in the field of technological change and its effect on workers in recent years. The discussion of the subject has proceeded along similar lines of speculation. The primary reason for increased interest and concern is that technological change has been experienced in the last decade or so, Can. which has been experienced in the last decade or so, which took place in earlier years. The rate of technological change has accelerated in recent years, and some of the changes themselves have differed markedly in character from those which previously occurred. It is the variety and the rather different nature of technological change over the past decade which has led to apprehensions about it and its effects.

A second reason why technological change merits consideration today is that it is turning industry's manpower requirements in new directions. For instance, what needs for highly skilled and technical manpower have been increasing while requirements for many other

February 1, 1961.



1105744

Technological Changes and Their Impact on Employment and Occupations

1.

Introduction

The purpose of this report is to analyze the technological changes which are occurring in the Canadian economy, and to outline some of their manpower effects. The discussion will be based on the research that has been undertaken to date by the Manpower Resources Division of the Economics and Research Branch of the Department of Labour as part of a broad manpower training research program. Although this research has not been completed, it does throw some light on two major aspects of technological change: (1) its general effects on employment and output; and (2) some of its particular effects on occupations and skill requirements.

Much has been said and written about technological change and its effect on workers in recent years. Discussion of the subject has generated both emotion and speculation. The primary reason for increased interest and concern is that technological change, as it has been experienced in the last decade or so, has differed in at least two important respects from that which took place in earlier years. Innovations have recently been introduced at an accelerating pace, and some of the innovations themselves have differed markedly in character from those which previously occurred. It is the rapidity and the rather different nature of technological change over the past decade which has led to apprehension about it and its effects.

A second reason why technological change merits consideration today is that it is turning industry's manpower requirements in some new directions. It is clear, for instance, that needs for highly skilled and technical manpower have been increasing while requirements for many other

in 2023 with funding from

University of Toronto

occupations have been lagging. As a result, trained manpower today is basic to the effective economic development of Canada to a much greater degree than in earlier years. If our needs for trained manpower are to be met, it is important that a clear picture be developed of our changing manpower requirements and of their implications for education and training.

This report will review the kinds of technological changes which have been occurring in recent years in five selected industries in which research studies have been made. The general effects of these changes on employment and output will be discussed, as well as their specific effects on individual occupations. The kind of technological changes occurring in business offices will then be outlined and their effects analyzed. A few comments will then be made on the changing occupational structure of the labour force in this country during the past several decades so that the specific occupational trends discussed earlier can be seen against the broader setting of what is taking place generally. Finally, in some concluding observations an attempt will be made to spell out some of the implications of the information and data presented as far as employment and training are concerned.

The Department of Labour has been studying changing requirements for skilled and technical manpower and the reasons for them since the summer of 1956. At that time a skilled manpower training research program was initiated by the Department in cooperation with other directly interested federal and provincial agencies, management and worker organizations, and other bodies. Its objective was to obtain information on changing needs for professional, skilled and other types of manpower in Canadian industry, on the available supplies of these types of workers, and on the adequacy of existing training

occupations have been lacking. As a result, trained manpower today is liable to the effective development of demands for a much greater degree than in earlier years. If our needs for trained manpower are to be met, it is important that a clear picture be developed of the changing manpower requirements and of their implications for education and training.

This report will review the kinds of technological changes which

have been occurring in recent years in the selected industries in which research studies have been made. The general effects of these changes on equipment and output will be discussed, as well as their specific effects on technical occupations. The kind of technological changes occurring in technical occupations will then be outlined and their effects analyzed. A few comments will then be made on the changing occupational structure of the labor force in this country during the past several decades and on the specific occupational trends discussed earlier can be seen against the broader setting of what is taking place generally. Finally, in some concluding observations an attempt will be made to spell out some of the implications of the information and data presented as far as equipment and training are concerned.

The Department of Labor has been studying changing requirements for skilled and technical manpower and the reasons for them since the summer of 1950. At that time a skilled manpower training research project was initiated by the Department in cooperation with other directly interested Federal and provincial agencies, management and worker organizations, and other bodies. The objective was to obtain information on changing needs for technicians, skilled and other types of manpower in selected industries, on the availability of these types of workers, and on the adequacy of existing training

facilities in industry and public institutions to meet the emerging needs. The various manpower effects of technological change have formed an important part of this research program.

This work has been under the general direction of an interdepartmental skilled manpower training research committee. In 1957, an advisory committee on technological change was established in order to assist the interdepartmental committee in identifying the problems requiring attention in the area of technological change, and to suggest types of studies most needed in this field. The advisory committee is composed of individuals from management, organized labour, government, universities and a few other interested agencies.

Before discussing some of the technological changes which have been taking place during recent years, it is necessary to say a few words about the meaning of this term.

The phrase "technological change" suggests for most people such important events as the invention of the steam engine, the printing press, or the wheel. These events, which greatly affected the development of civilization, were indeed outstanding examples of technological change. In considering such changes, however, at the present time, it must be kept in mind that most of them are small, although in their total effect they have great significance.

Most technological change in industry can be classified into the following types: (1) new products; (2) changes in old products to increase their marketability or to make production easier and cheaper; (3) new materials;

Facilities in industry and public institutions to meet the existing needs.
The various management efforts of technological change have focused on important
part of this research program.

This work has been under the general direction of an international-
method oriented research training research committee. In 1957, an advisory
committee on technological change was established in order to assist the
international committee in identifying the problems requiring attention
in the area of technological change, and to suggest types of studies most
needed in this field. The advisory committee is composed of individuals from
government, organized labor, government, universities and a few other
groups.

Further along the way of the technological change which have been
being done under these terms, it is necessary to say a few words about
the meaning of this work.

The concept "technological change" suggests the most needs with
important events in the evolution of the atom energy, the military power, or
the space. These events, which greatly affected the development of civilization,
have been indeed outstanding examples of technological change. In considering
and comparing, however, at the present time, it may be said to have been one
of them are really, although in their total effect they have great significance.

Most technological change in industry can be classified into the
following types: (1) new products (2) change in old products to increase
their productivity or to raise production faster and cheaper; (3) new methods

(4) new sources of power; (5) increased mechanization or automation of production processes; (6) communication and other services; (7) the use of computing machines; and (8) changes in plant organization and layout.

The ongoing process of industrial development usually involves the introduction of more than one of these changes at a time. Use of a new material may require a new production process. Use of a new source of power may involve a change or at least an increase in mechanization. The introduction of a new product may well bring about many different technological changes in a plant and an industry.

If the purpose of this report were to develop an abstract theory of technological change, it would be desirable to begin with a precise, unambiguous definition of the term. This is, however, not the concern here. It is rather to discuss the broad types and processes of technological change in selected industries. For this purpose, it is sufficient to bear in mind that technological changes are numerous and heterogeneous in character affecting different parts of the economy in different ways.

2.

Recent Technological Changes in Five Industries

During the last three years, the Department of Labour has been carrying out field studies of technological changes and their effects in five industries. The industries studied, and on which the following analysis will be based, are electrical and electronics, heavy machinery, household appliances, automobile manufacturing, and automobile parts. Interviews were conducted in from five to twenty plants in each of these industries. The plants visited

were located in Ontario and Quebec, and the interviews were with the principal management officials as well as with a number of union officials in the case of the last two industries.

Reports have been issued, under the auspices of the interdepartmental committee mentioned earlier, on the studies undertaken in each of these five industries. They are included in numbers 2, 3 and 8 of the Skilled Manpower Training Research Program series. Copies can be made available to anyone interested.

Information was obtained on technological changes in each plant during recent years, in as much detail as possible, and on the effects of these changes on employment and occupations. Data were also obtained on the composition of the working force in each plant by department and occupation, as well as on the types of training activities carried out in the plants surveyed.

It is necessary to point out that the information collected on specific technological changes represents only a part of a larger number of such changes which have taken place in recent years in the plants visited. Although efforts were made to obtain a complete story, it is possible that many small changes, for example, were forgotten and so were not reported. The relatively large changes, on the other hand, might have created an impression which lasted for some time so that those concerned remembered them clearly and were able to recall them in detail. Thus, the cases on which information was obtained may not be representative of the total universe of such changes. Nevertheless, it is felt that the findings show quite clearly the broad scope of the changes which have been taking place and something of their character.

Another word of qualification is necessary. This analysis concentrates exclusively on the direct effects of specific changes, that is, on their effects on the workers directly involved in the productive operation studied. The secondary manpower effects are not reported although attention is called to their importance in reports of the studies made. These secondary manpower effects could occur in the plant where the change was initiated or in an outside plant within or without the same industry. The two main difficulties in determining such secondary effects in any precise way are implicit in their nature. First, the secondary effects of any specific change in technology have a diffused character and are not readily identified wherever they occur as having resulted from the particular change under study. Second, time lags of various durations occur between the change and the primary effects on the one hand and the secondary effects on the other. These time lags tend to obscure further the relationship between specific technological changes and their full manpower effects.

The specific changes on which information was secured in the five industries studied were analyzed in terms of the 'type' of change they represented. To some extent at least, each of the different types of change has its own characteristic manpower effects, and this information in conjunction with the frequency with which the various changes were encountered provides some insight into the manpower implications of the changes taking place.

The technological changes on which information was obtained are presented by type and frequency in Table 1. It is clear from this table that the most common type of technological change differed in each of the industries studied. In the case of the electrical and electronics industry, it was the introduction of new products or operations. The installation of

Table 1

CLASSIFICATION OF SPECIFIC EXAMPLES OF TECHNOLOGICAL CHANGE
IN FIVE MANUFACTURING INDUSTRIES (1)

	<u>Electrical & Electronics</u>	<u>Household Appliances</u>	<u>Heavy Machinery</u>	<u>Auto Parts</u>	<u>Automobile</u>
TOTAL	38	114	35	79	62
Improved Tooling	0	6	1	3	4
Automatic and Semi-Automatic Machinery	10	23	4	8	6
Integrated Materials Handling. 2		10	0	2	3
Automatic Controls	0	8	2	0	3
Changes in Product Design and/ or Methods of Fabrication. 5		13	3	9	8
Use of New Materials	3	19	4	2	2
Improvement in Non-Automatic Machinery	2	3	3	41	13
Improved Hand Tools	0	0	0	0	2
Improved Materials Handling... 2		13	0	10	14
Introduction of New Product or Operation	12	11	5	4	3
Redesign + Integrated Materials Handling	0	0	0	0	2
Improved Inspecting or Testing Equipment	2	3	12	0	1
Changes in Materials and Changes in Prod. Technique. 0		5	1	0	1

(1) Based on information obtained from selected large firms located in Central Canada, 1956-1960.

automatic and semi-automatic machinery was the most common type of change in the household appliance industry. Improved inspecting or testing equipment was the most frequent kind of change in the heavy machinery industry. Improvements in non-automatic machinery were the most common type of change in the automobile parts industry, while improved materials handling and better non-automatic machinery were of approximately equal importance in the automobile manufacturing industry.

The installation of automatic and semi-automatic machinery, changes in product design and/or methods of fabrication, and the introduction of new products or operations were all types of technological change which occurred with at least some frequency in all five of the industries studied. It is interesting to note that one of the most dramatic kinds of technological change, the integration of materials handling through the use of transfer equipment, was found in four of the five industries studied. Another relatively advanced type of technological change, the use of automatic controls, was found in three of the industries, although not very extensively. Attention might also be drawn to the frequency with which new materials are being introduced in the household appliance industry.

Some of these changes obviously involve many more workers than do others. For this reason their full significance can be appreciated much better when their effects on employment are indicated and some examples are given to illustrate them.

The use of automatic machinery usually eliminates a significant proportion of semi-skilled workers previously engaged in this type of operation. In some cases, more maintenance personnel are required to stand

by continuously because of the considerably increased cost stemming from any prolonged breakdowns. The calibre of maintenance personnel needed tends to rise and competence in several related maintenance trades comes to be preferred.

An example of this type of change is the installation of an automated plating machine in one firm. Before the installation of the machine, 39 men plated a given square footage of surface in one day. On the automated equipment, 23 men were able to load, unload and inspect the same square footage. Three maintenance mechanics, however, were subsequently required to be in attendance all the time to prevent or repair breakdowns.

Greater use of integrated materials handling equipment usually eliminates the jobs of unskilled materials handlers or increases the output significantly of processes utilizing semi-skilled workers. Normally, maintenance requirements rise after the installation of such transfer machines. In some cases full-time maintenance is needed.

An example of this type of change is the installation of transfer machines in automobile hood stamping operations. Before this piece of equipment was installed, 13 men were working on this operation, whereas afterwards only 6 were involved with an output which increased by 40 per cent. Maintenance requirements increased and the calibre of maintenance personnel attending to the equipment was higher.

In the industries examined, the increasing use of automatic controls has had a limited effect on manpower. By automatic controls are meant devices (mechanical, electrical, hydraulic or otherwise) which regulate the operation of a machine or piece of equipment. These devices do, however, often result

in a substantial improvement in the quality of the final product. If manpower displacement occurs, it tends to be concentrated within the inspection staff. There is some increase in maintenance requirements in respect to the control mechanisms.

A change in product design and/or methods of fabrication can affect the number and types of workers in various ways. It can have a far-reaching effect on manpower requirements, as in the case of the use of printed circuits in the electronics industry which reduced the need for solderers and other types of semi-skilled workers. Another example is the substitution of induction heating equipment for ordinary gas furnaces in the extrusion of valves in an automotive parts company. This change eliminated the heater operator and thus meant a saving of manpower, but it also created difficulties in the training of hammermen since under the old system the heater operator's job was a step in the training process towards the position of hammerman. There was a considerable increase in this case in electrical maintenance on the high frequency generator units.

The installation of improved non-automatic machinery is a type of change whereby a newer and faster machine replaces an older lower-capacity one. Usually, output is increased significantly in the operation concerned which may or may not reduce total employment, depending on the level of total production which is maintained after the change. No occupational or skill changes of any significance occur and maintenance requirements do not seem to change significantly.

An example of such a change is the replacement of a milling machine with a broaching machine for the finishing of gasket surfaces on a cylinder block. The milling machine, in this example, finished 35 units per hour with one operator, while the broaching machine which replaced it had a production rate of 75 units per hour with one operator.

The introduction of a new product or operation usually constitutes an addition to the activities of an establishment. As such, it raises manpower requirements in most categories of employment, provided the work force engaged in producing the other products is fully utilized. Wherever additional activities are commenced, the establishment invariably adopts the most up-to-date techniques that are appropriate to the planned level of output.

An example of this type of change is the recent commencement of V-8 engine production in a large establishment. This created employment for approximately 300 people, out of which about 40 per cent were in skilled occupations. The large proportion of skilled jobs reflects the very high degree of mechanization and integration of this production process.

This is perhaps sufficient by way of example to convey the flavour, as it were, of what has been happening in the five industries studied and, undoubtedly, in many other industries to a greater or lesser degree. It should be noted that manpower requirements in the industry in question are frequently reduced, that output almost always increases either in quantity or quality or both, and that needs for semi-skilled workers tend to drop, while those for skilled maintenance workers and some other highly technical groups frequently rise.

General Effects of Technological Change on Employment and Output

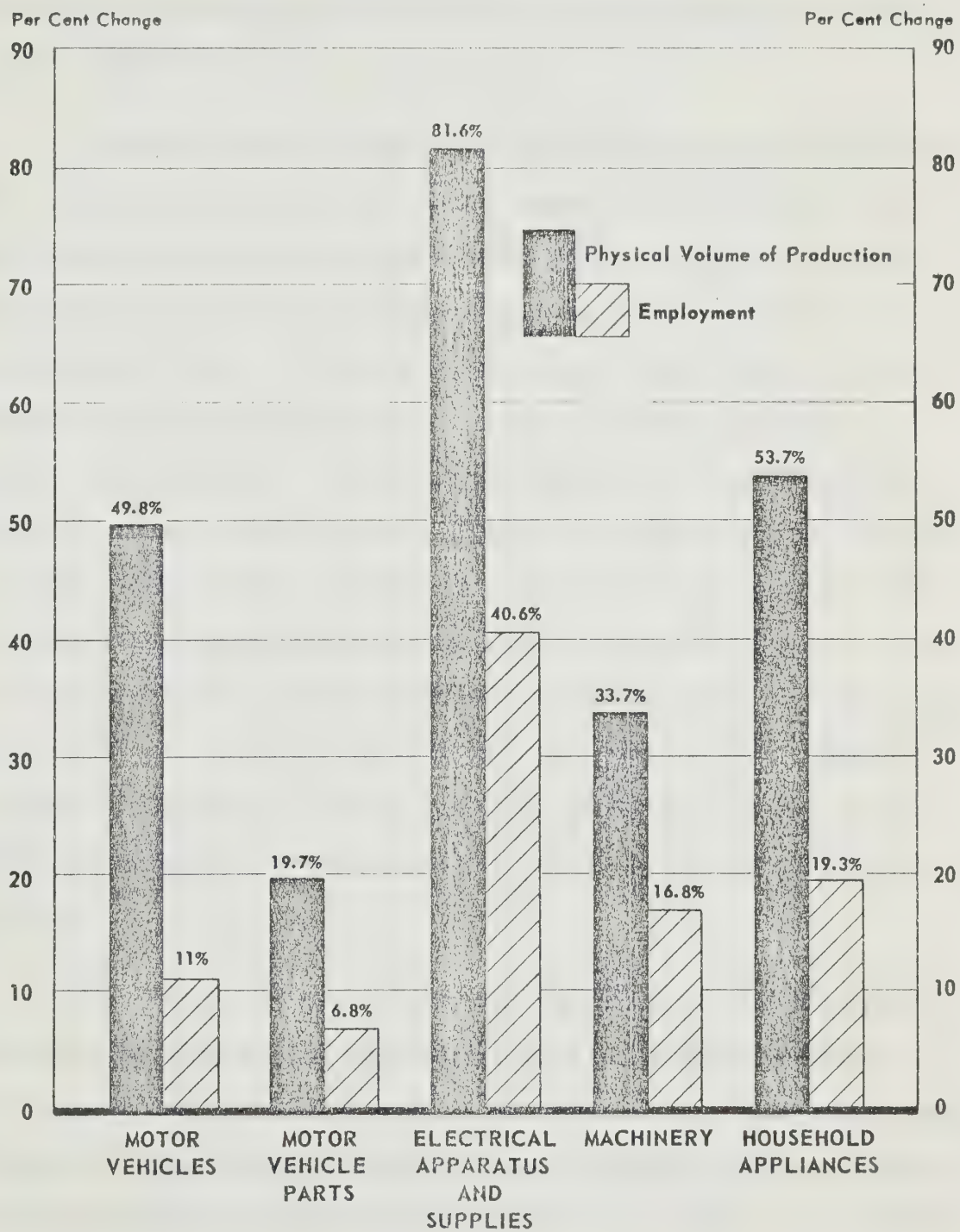
The studies carried out to date indicate that associated with these technological changes have been substantial increases in productivity in all of the industries surveyed. One of the prime reasons, of course, for making technological changes is to increase the volume of production or to lower unit costs. One of the best indications, therefore, of the effects of technological change on employment would be data on changes in output per worker. Unfortunately, in Canada government statistics of this kind have not yet been developed to the point where they can be used for this purpose.

It is possible, however, to give some indication of changes in output per worker by reviewing trends in employment and volume of production in the industries studied. Since production and employment can vary considerably from one year to the next, a better appreciation of the underlying trends can be obtained by averaging three of the most recent years for which data are available, 1957-1959, and comparing this average with the situation in 1949. The following information is developed on this basis. It should be mentioned that these data refer to all establishments in the industries covered rather than only to those which were visited in the studies on technological change.

The data indicate that in all five industries the physical volume of production increased considerably more than did total employment. A glance at Chart 1 shows this. In the motor vehicle industry, the volume of production increased by 50 per cent, while employment rose by 11 per cent; in the motor vehicle parts industry the comparable figures were 20 per cent and 7 per cent; in the electrical apparatus industry the figures were 82 per cent and 41 per

Chart 1

EMPLOYMENT AND OUTPUT TRENDS IN FIVE MANUFACTURING INDUSTRIES, 1949 to 1957-59 (1949 = 100)



Source: D.B.S. data on volume of production and employment.

THE UNIVERSITY OF CHICAGO
DEPARTMENT OF CHEMISTRY
1155 EAST 58TH STREET
CHICAGO, ILLINOIS 60637



cent respectively; in the machinery industry they were 34 per cent and 17 per cent respectively; and in the household appliance industry volume of production increased by 54 per cent and total employment rose by 19 per cent. In addition, there were also declines in hours of work over the same period in at least some of these industries.

Another general employment effect noted was the relative decline in direct production labour and the relative rise in indirect labour. Direct production labour includes all employees except executive and supervisory officials, managers, professional and technical employees, superintendents and factory supervisors above the working foreman level, those engaged in retail or wholesale sales, new construction, and clerical staff. Information here is only available for three of the industries studied and covers the period 1948-1958. In the automobile industry, direct production labour as a proportion of total employment declined from 83 per cent to 73 per cent over this period, whereas indirect labour rose from 17 per cent to 27 per cent. In the automotive parts industry, direct labour also declined, but to a lesser extent, dropping from 84 per cent to 73 per cent over this period. In six plants for which statistics are available in the household appliance industry, direct production labour declined from 73 to 63 per cent of total employment over a comparable period.

The increase in productivity and the changes in the proportion of direct and indirect labour give some indication of the effects of technological change on manpower. It must be remembered, however, that productivity trends depend on other factors as well--changes in quality, changes in 'make or buy' policies, variations in volume produced and hours worked, all are additional

factors which affect productivity. The only statement which can safely be made is that a large proportion of the apparent changes in output per worker in the industries studied can be ascribed to the effects of technological change.

The implications of a sizable increase in productivity are several. First of all, it means that a given work force is now able to produce a greater volume of output than previously. It further means that any given expansion of production would induce a slower increase in total employment than would have been the case before the introduction of technological changes, thus reducing employment opportunities for new entrants into the industry. If no expansion, or too slow an expansion of output occurs, it may result in a reduction in the number of jobs in a plant. The impact of displacement will be eased if the industry itself is growing, if other industries dependent on it are developing (i.e., service stations, garages, highway building, tourism), or if employment in the economy as a whole is expanding. In a time of recession, however, its impact will be more severely felt.

A sizable gain in productivity also usually indicates a considerable increase in capital investment per worker. Such an increase in capital investment tends to expand employment opportunities in such areas as maintenance and the capital goods industries. Although increased employment opportunities in maintenance and other areas of work are evident in Canada, it is important to note that expansion of employment in the capital goods industries as a potential offset to possible displacement is minimized because in several industries the bulk of production machinery is imported from other countries, being designed and manufactured elsewhere. In the five industries studied, this fact was particularly evident.

The relative decrease in direct production workers and the increase in indirect labour have pushed the over-all skill level of employment upwards. This has been brought about partly by the fact that displaced labour is more apt to be semi-skilled or unskilled workers engaged on production work, where the manpower impact of technological change is usually concentrated. A second contributing factor is that new products, improved and more complex production methods, greater quality control, and increasing research and development, all have resulted in a need for more technical specialists on the indirect labour side, such as engineers, technicians of many kinds, and a wide range of other staff specialists. In the automobile industry, for example, salaried employment increased substantially from 1948 to 1958. In manufacturing administration, in particular, there was a fast rate of growth due to expanding functions such as production planning, scheduling, quality control, complex inspection and time study.

Employment in the engineering departments of Canadian automobile firms seemed to experience a relatively slow rate of expansion from 1948 to 1958. One of the reasons for this is that a considerable portion of the engineering work is and has been done by parent companies outside of the country. A similar situation occurred in the household appliance industry. The need for engineers was, however, more pronounced in the electrical and heavy machinery industries, where more research and more development work were being carried out.

The more complex machinery and equipment being used in manufacturing plants as a result of technological change have resulted in increased maintenance. Greater stress is being placed on preventive maintenance to reduce

costly production breakdowns. The level of skill required of maintenance workers is tending to rise because of the demand for knowledge of electronics on the part of electricians, and a knowledge of hydraulic and pneumatic systems by machine repairmen. Maintenance welders are required to deal with a greater variety of metals and with new welding techniques. Similar trends are occurring in many other skilled occupations.

Toolroom operations have gained in importance. More complex machines increase the number of tools required. More frequent model changes also require tools and dies to be changed more often.

Inspection has generally increased in importance both in terms of numbers of workers and in upgrading of skills. Quality control techniques are becoming more complicated, involving in various cases statistical quality control, x-ray inspections, ultrasonic testing, and hardness testing. The level of education required by the inspection staff is consequently rising. There are, of course, many inspection functions which are still routine in nature.

Assembly operations, generally speaking, have not yet been greatly affected by changes in production techniques, for the reason that these operations have thus far lent themselves less readily to integrated mechanization than have machining operations.

Automatic transfer equipment and conveyor systems have replaced much unskilled labour formerly employed in materials handling.

4.

Effects of Technological Change on Specific Occupations

So far, attention has been directed at the general effects of technological changes on employment. It is important to know more specifically what kinds of occupations are being affected, both quantitatively and qualitatively, so that a clearer appreciation of the displacement and training consequences of technological change can be gained.

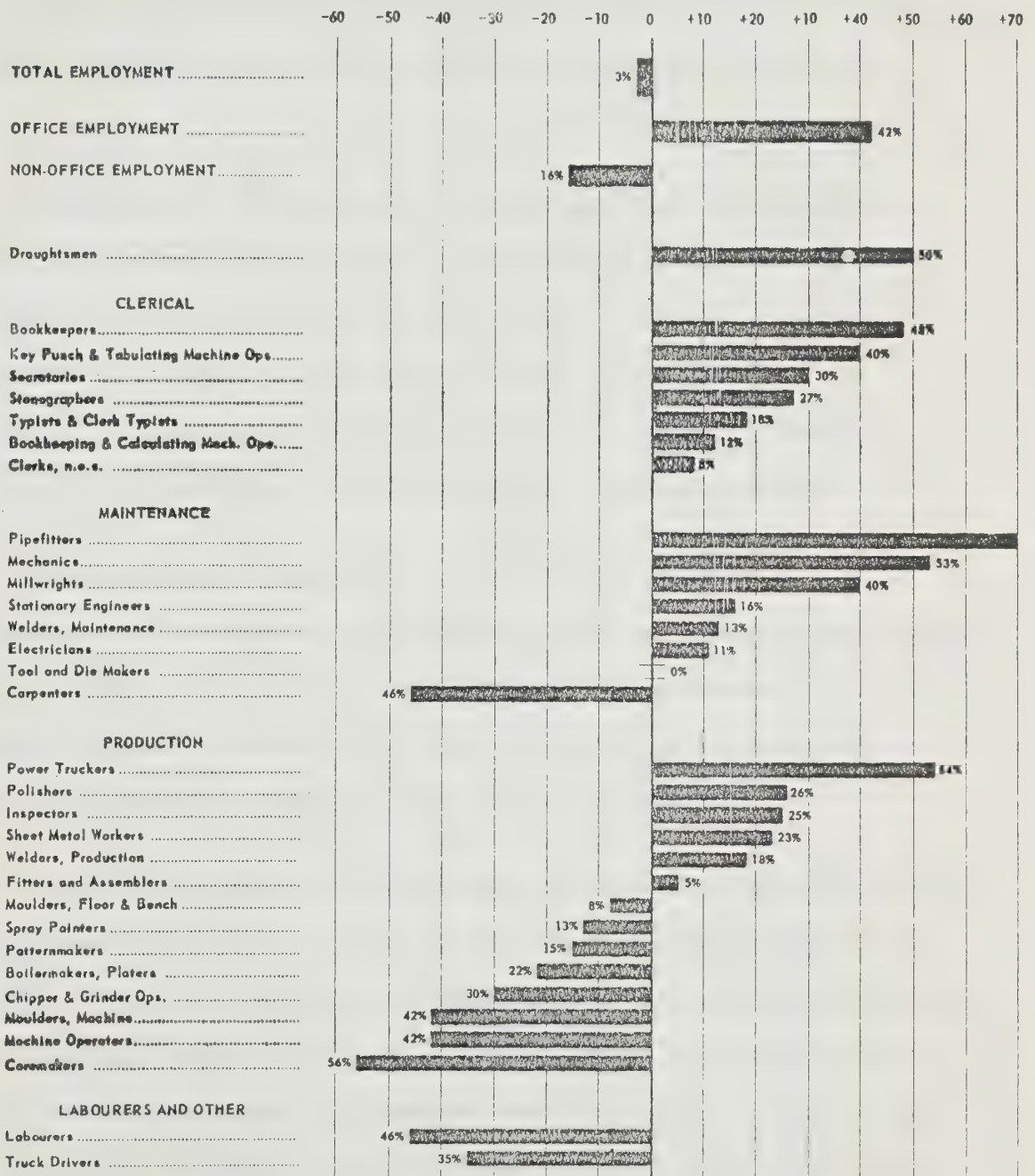
The incompleteness of the data on employment by specific occupations obtained through interviews and the fact that what were obtained covered time periods of various duration, prevented a full analysis of this subject from interview reports. Consequently, data obtained from the Department of Labour's Annual Wage Rate Survey were used for this purpose. In this survey, data are reported by individual establishments on the number of workers at each rate of pay in selected occupations. Short descriptions of the occupations for which information is requested are provided.

This information for the five industries studied over the period 1950 to 1959 is summarized in Chart 2. Again it should be noted that the data do not cover all reporting establishments in the industries selected, but only the large ones. The trends shown here, therefore, may not be indicative of what is happening in small establishments. The larger firms, however, account for the majority of employment in the industries studied. The analysis is based on average employment in each occupation in the first and last three years of the period for which data are available. Table 2, at the end of this report, provides in greater detail the data shown in Chart 2.

Chart 2

**PERCENTAGE CHANGES IN AVERAGE EMPLOYMENT IN SELECTED OCCUPATIONS
IN FIVE MANUFACTURING INDUSTRIES***

BASED ON AVERAGE EMPLOYMENT FOR 1950-52 AND 1957-59



* Electrical and electronic, heavy machinery, household appliances, automobiles, and automobile parts.

Source of basic data: Department of Labour Annual Survey of Wage Rates.

The chart shows that, while total employment in selected large plants in the five industries declined slightly over the approximately seven-year period, office employment (clerical, administrative, and professional employees) increased substantially, and non-office employment (the remainder) showed a sizable drop. This was true in each of the five industries, as well as in total.

In the case of the individual occupations, there is considerable variation in the changes taking place in the different industries. Nevertheless, an underlying pattern emerges which is shown in Chart 2. The only office occupations covered by these data and shown on the chart are the clerical ones. No data are available on professional and sub-professional, technical and other specialist office occupations, except draughtsmen.

Amongst clerical occupations, clerks showed the slowest rate of growth, but even this was greater than over-all total employment in the plants covered by these data. The other clerical groups shown increased more rapidly, in some cases much more rapidly, than clerks. Only one of them, however, bookkeepers, increased more than did total office employment.

The chart, therefore, indicates what was happening not only in the occupations covered but also in those for which no data are available. It suggests that there must have been a very considerable increase in non-clerical office occupations. The 50 per cent rise in draughtsmen is an indication of this. Even greater gains must have occurred over the period in many of the professional, highly technical, administrative, and staff specialist occupations for which data were not secured in the annual survey. Many of these are undoubtedly among the fastest growing occupational fields in the labour force today.

Returning to the clerical group, it should be pointed out that the larger growth rates indicated for the various office machine operators as compared with clerks reflect the increasing mechanization of office work, and point up the differential impact that technological change is having on these two groups of workers.

Diverse trends were evident among maintenance occupations in the different industries, but again a general pattern emerges. By and large, these occupations were growing relatively fast. The most rapid growth was shown by pipefitters, millwrights, and maintenance mechanics. The picture for tool and die makers is obscured, to some extent, by the practice of subcontracting this work to job shops which is developing in some industries. The only occupation in this group showing a decline was carpentry. This may be due partly to varying amounts of construction work and partly to more skilled work of this nature being contracted out.

Turning to production workers, the tendency for changes to vary in the different industries is even greater, but general patterns can still be seen. The large increase in power truckers is associated with, but does not account for, the declines in labourers and truck drivers. Reference has already been made to the expansion in inspection work, and the marginal impact of technological change in these industries on assembly operations. The growth of production welders was heavily concentrated in the automobile industry.

The decline in machine operators occurred in the electrical, automobile and automobile parts industries, where mechanization of these operations has been considerable. The growing mechanization of foundry work, and of painting and plating operations, accounts mainly for the other declines shown.

It must be emphasized that this chart and table do not cover all occupations in the various groups indicated. The occupations shown, however, are sufficiently numerous to indicate in some detail the occupational areas which are growing, declining or remaining relatively stable. The shift in the occupational structure of these industries towards non-clerical white-collar occupations and, in the plant, to the maintenance trades and some production tradesmen is clearly evident. These shifts are further evidence of the growing emphasis in manpower requirements on relatively high degrees of skill, technical knowledge, and specialist training of various kinds.

5.

Office Automation and Its Employment Effects

One of the most dramatic changes that has taken place in the Canadian labour force since the turn of the century is the rise in clerical employment from the ninth to the second largest broad occupational group. As the clerical work force has grown, its composition has changed. In 1901, 67 per cent of all clerks were men. By 1960, a little over 61 per cent of a vastly increased clerical work force was made up of women. The male workers in these occupations now tend to cluster in the supervisory and more mechanical jobs, while women make up the great bulk of workers in typing, stenographic and secretarial jobs.

Fundamental changes are also occurring in the nature of clerical work itself. The classical concept of the clerk dates from before the turn of the century when the black-coated worker, with visor and sleeve guards, accounted for the paperwork needed in the small family undertaking or partnership. As businesses grew in size, the organizational expedient adopted to handle the increased paperwork was that of a departmental breakdown based on function or geography into manageable individual and group work components. This was the

trend through the first five decades of this century, which necessitated and explains the dramatic expansion of clerical employment. The problems which consequently developed were those of communication, co-ordination, and control. Mechanical data processing and more recently the electronic computer are now providing, increasingly, the means whereby these problems are being overcome.

This break-through in the means of handling clerical work may result in a slackening in the growth of clerical employment. From 1941 to 1951, for example, about 50 per cent of the increase in clerical employment was due to the fact that the proportion of such workers in the industries where they are predominantly employed was increasing. The other one-half of this expansion was due to the over-all growth of these same industries.

In the more recent decade, however, only 5 per cent of the growth which has occurred in clerical employment can be attributed to the increasing intensity of their employment in specific industries. Most of the growth in clerical employment over this decade was due to the over-all expansion of the industries already employing such workers.

It would appear, therefore, that office mechanization and automation are already accounting for some slackening in the rate of clerical employment expansion, and that this trend may well continue.

The research which has been done to date by the Economics and Research Branch of the Department of Labour on the impact of technological change in business and other offices on employment has been limited. Although the impact of office mechanization and of organizational and systems changes on clerical and white-collar occupations is the full area requiring

investigation, research has concentrated on electronic data processing, the most recent but potentially most significant of all the changes that are taking place in the office employment area.

In the summer of 1958, a case study of the effects of the introduction of electronic data processing in a large Canadian insurance company was initiated. This study has aimed at obtaining as much detailed information as possible on the manpower and other changes which occur when a significant step of this kind towards office mechanization is taken. To supplement this specific study, a broad survey of the current status of electronic data processing in Canada at the beginning of 1960 has also been undertaken. A questionnaire was mailed to all known users of computers at that time to obtain factual information on the kinds of work being done by this equipment, the number and types of computers in use, the types and sizes of firms using them, and the number of people employed in the occupations associated with them. There was a 100 per cent response to this survey.

There were 89 computers of all sizes operating in Canada at January 1, 1960, and these were distributed amongst 69 different organizations at 72 establishments. There were 13 organizations operating 2 computers, 1 organization operating 3 computers, and 1 operating 4 computers.

While 89 computers in Canada at the beginning of 1960 may seem a small number, it is significant that there were no computers at all in this country just four years earlier. Moreover, the number of computers in operation has quadrupled in the past two years, and if the present rate of expansion

were to continue over the coming decade, electronic data processing could become the dominant characteristics of office operations in Canadian business, industry and government.

At present, electronic computers are heavily concentrated in a few areas. Almost one-half of all the EDP installations in the country are in Montreal and Toronto, and more than three-quarters of the large computer installations are to be found in these two cities.

About one-quarter of all computers are located in manufacturing firms, with another one-quarter being in the community service industry which includes universities, hospitals, business service firms and computer service bureaux. Approximately 15 per cent of all computer installations are in government departments and agencies, while an equal number are in financial organizations, especially insurance companies. *→ where? predominate*

Computer applications range all the way from integrated data processing, including customer billing, on the part of some insurance companies, to the calculation of a least-cost feed formula for hogs by a commercial service bureau for one of its customers. Approximately one-half of total computer time was found to be used for business data processing, and one-half for scientific and engineering computations. If the total amount of computer time, however, is weighted to reflect the differing capacities of large and small installations, commercial data processing applications outweigh scientific work by a ratio of 3 to 1. In this connection, it should be pointed out that a good deal of the engineering and scientific computation for research purposes is carried out on analogue computers which were not included in the survey on which these figures are based.



The impact of EDP extends beyond the bounds of the organizations presently equipped with such machines. Thirty-one of the 89 installations in operation in this country at the beginning of 1960 rented out time to a total of 116 other users. This number of other users is impressive, but the proportion that the total number of hours so rented per week bears to the extent of over-all computer utilization is small.

Although it was not possible to indicate how many jobs, if any, the 89 computers in Canada may have eliminated, the survey found that they have created 1,215 full-time jobs that did not exist prior to the introduction of EDP. An additional 646 people work part-time on the operation and maintenance of these computers. It might be added that more than 3 out of 4 of all the new EDP jobs are filled by male workers.

Out of every 100 of the new full-time jobs, 29 are for programmers, 14 are for administrators, 12 are for computer operators, 11 are for computer technicians, 10 are for project planners, and 24 are a variety of other jobs, such as peripheral equipment operators, data typists, tape librarians, computer centre receptionists, and those key-punch operators and verifiers whose full-time work is preparing input for the computer.

Except for some of the jobs in the 'other' category, all of these new positions are highly skilled in nature. In almost every case, the jobs call for technical or administrative specialists of a high calibre who have considerable formal education and training and, in most cases, have, in addition, varying amounts of specialized training and experience.

No attempt was made in this mail survey to assess the actual or potential employment impact of EDP. The complexity of this feature of EDP rendered a mail enquiry respecting it inadequate. This, however, will be one of the objectives of further research in this area. It may be of some interest to note that total employment in the establishments with computers as of January 1960 was approximately 177,000 people. As might be expected, a considerable proportion of this total was office employment, about 42 per cent.

This brief review of the current status of electronic data processing in Canada is not meant to imply that office mechanization today is solely or primarily of this nature. As pointed out earlier, office mechanization ranges all the way from the use of typewriters and small desk office machines to these large computers. The significance of electronic computers is that they, more than any other innovation in this area, will probably alter very significantly the way in which office work is organized and gets done and, thus, change the occupational composition of the office work force to a considerable degree. As indicated earlier, the use of computers and a wide range of other high-speed and large-volume office machines is already resulting in a slowdown in the rate at which clerical employment has been expanding.

6.

Changing Occupational Composition of the Canadian Labour Force

It is helpful to view the specific occupational changes discussed so far against the background of the broad occupational trends which have been taking place in this country during the last half century. These are shown, for the period 1901 to 1960, in Chart 3.



In this chart, occupations have been grouped into six broad categories, of which the two largest are "white collar" and "blue collar". Included in the former group are clerical, professional, managerial, commercial and financial occupations, while the latter is comprised of manufacturing and mechanical, construction and unskilled labouring occupations. The resource group includes fishing, logging and mining occupations.

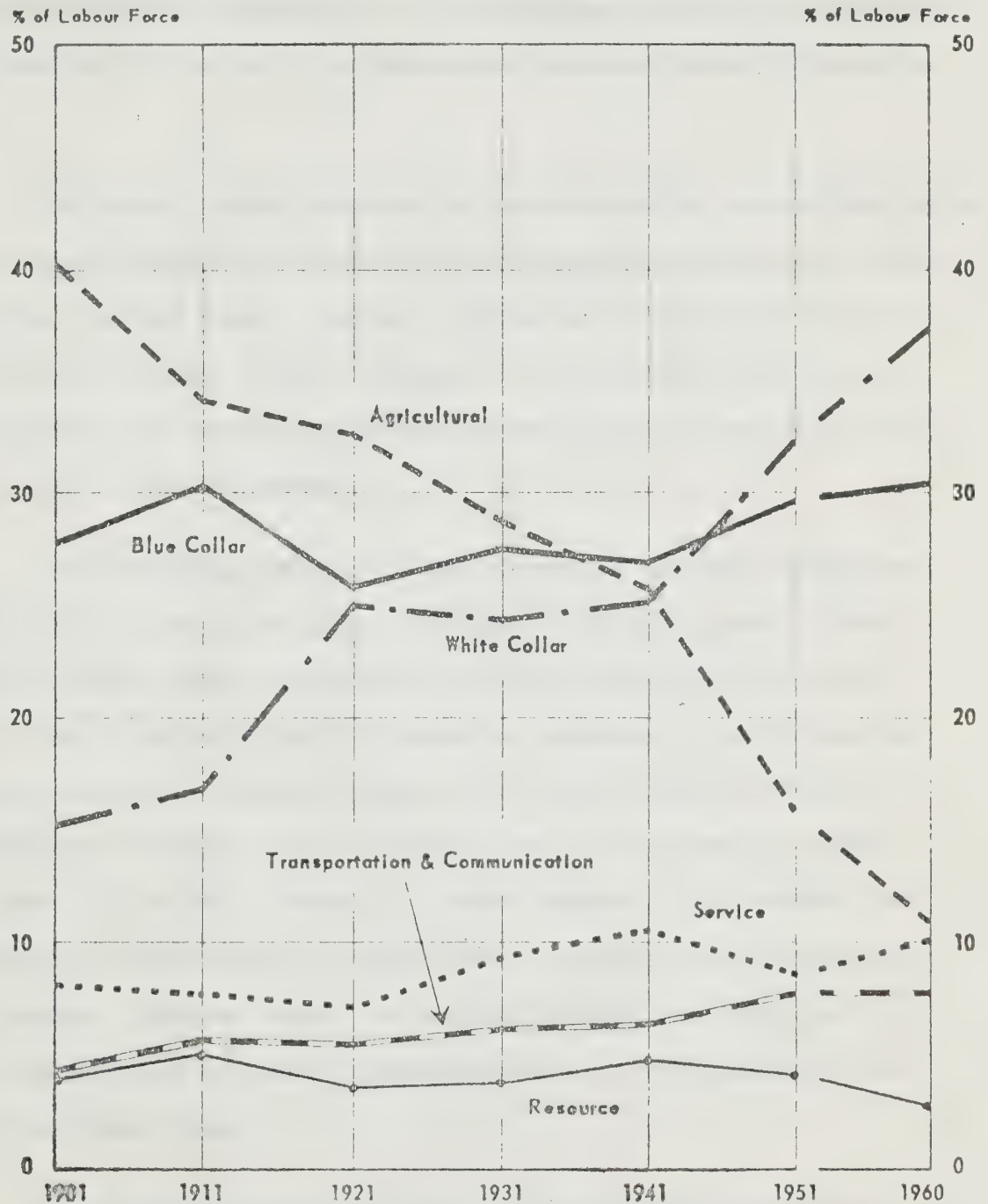
Chart 3, it needs to be added, shows the changing occupational structure of the labour force in terms of the percentage which each group is of the total at successive decades.

It can be seen immediately that occupational trends have not developed smoothly. Each occupational group has experienced considerable variation over the whole period in the proportion which it represents of the labour force. White-collar occupations, as a whole, for example, grew very rapidly during the decades straddling the two World Wars. Agricultural occupations have declined proportionately over the whole period, but it was only after 1939 that they showed a numerical drop. There have been alternating increases and decreases in the proportion of blue-collar workers in the labour force, but the net result has been that this occupational group now is about the same relative size as it was 60 years ago. Transportation and communication occupations have undergone a sizable proportionate increase, service workers are up slightly, while resource occupations are down.

Broadly speaking, changes in the economy's needs for various types of workers are a product of the varying rates of growth or decline of industries themselves as well as of shifts in the occupational composition of these industries. Needs for a certain type of skilled worker, for example, can

Chart 3

PERCENTAGE DISTRIBUTION OF THE LABOUR FORCE BY MAJOR OCCUPATION GROUPINGS, BOTH SEXES, FOR CANADA, 1901 - 1960.



Sources: 1901 - 1951 Censuses. Occupations were rearranged on the basis of the 1951 classification.
Figures for 1941 and 1951 exclude males on Active Service.

1960 figures are based on Labour Force Survey data for June 1960.

change because, (1) the industries which employ them are growing (or declining) faster than other industries, because (2) a larger (or smaller) proportion of such workers are being employed in the industries using them, or because both of these developments are taking place. To understand more fully occupational trends of the past, it is useful to distinguish the contribution of these two factors.

The fastest growing component of the white-collar occupations during the last 60 years has been the clerical group followed by professional occupations. During the last decade, however, professional occupations have outstripped clerical in their growth. Managerial and commercial and financial occupations have both increased substantially over the whole period, but not as rapidly as the other two groups.

The outstanding feature of the expansion of clerical occupations from 1931 to 1951 has been that about one-half was due to a growth in the intensity with which these occupations were used in almost all industries. This growth can be attributed to the tremendous expansion in record keeping and communications which has been required over recent decades to meet the great complexity of modern business organizations. During the last decade, however, almost all of the increase in clerical employment has resulted from the expansion of those industries which already employed a large proportion of these workers. In other words, the tendency for specific industries to employ clerical workers in greater proportions seems to have slackened considerably over recent years.

The picture is somewhat different for professional occupations. Over the past 30 years about three-quarters of the growth in professional

employment has been due to the expansion of industries which already employed these workers to a large extent. This expansion was heavily concentrated in government and community service. There has, however, also been a substantial increase in the proportion of each industry's labour force which is composed of professional workers. This latter trend seems to be continuing. In total, both industrial expansion and an increase in the intensity in the use of professional workers have contributed to the growth of their employment.

The expansion of managerial occupations has been due almost entirely to industrial expansion, particularly the growth of wholesale and retail trade where this occupation makes up more than one-quarter of all those in the industry.

Commercial occupations experienced their sharpest rate of growth in the early decades of this century and since then have continued to increase at a comparatively slow rate. The modest rate of increase during the past 30 years has been largely due to the decline of sales workers in trade. This change seems to have been the result of technological developments, such as the increasing use in retail stores of self-service techniques and other advances in sales procedures and equipment.

Amongst blue-collar occupations there have been some divergent trends. Construction occupations have grown considerably faster than the labour force as a whole in recent years, while labourers have declined. Manufacturing and mechanical occupations grew more than any other group from 1931 to 1951, but since then their proportionate increase has been slower than that of the labour force.

Many construction workers (i.e., carpenters, painters, plumbers) are employed outside the construction industry itself, and this must be kept in mind when considering changing needs for these workers. While the proportion of construction workers in the industries using them increased considerably from 1931 to 1951, this growth slackened during the last decade. In other words, construction occupations have continued to grow since 1951 only because the industries which already employed them in substantial numbers were themselves growing rapidly.

In the case of labourers there has been a decline in the employment of this occupational group in almost all industries during the last 30 years. The decline in the proportion of the labour force in this occupation would have been much greater had not some of the industries employing such workers in large numbers undergone rapid growth during the last few decades.

In the case of agricultural and resource occupations, by far the most significant change has been the tremendous decline in agricultural occupations. In 1901 this occupational group comprised 40 per cent of the whole labour force. By 1960, it constituted only 11 per cent of the labour force. Changes in other resource occupations--fishing, logging and mining--have been proportionately small.

In summary, the outstanding changes in the structure of the labour force over the past 60 years have been the sharp drop in agricultural workers and the rapid rise in white-collar occupations. As has been shown, these and other changes have not proceeded at an even pace but rather have been subject to ebbs and flows. During the past decade, the growth in clerical occupations has slackened, the rate of expansion of the professional work force has increased,

labourers and unskilled occupations have declined further as a proportion of the labour force, and the rate of growth of blue-collar occupations has dropped. These broad trends, particularly during the past decade, confirm the changes suggested by the earlier and more detailed analysis of technological change in this report.

7.

Concluding Observations

It is clear from the foregoing remarks that technological changes in the Canadian economy are varied and extensive in character, and that their effects on manpower requirements are substantial.

The wide range in the kinds of technological changes, as defined in this report, which are occurring should be noted. The new ideas from which they originate do not only emerge from scientific advances. They also arise in such fields as plant organization and production engineering, in personnel policies and industrial relations, in marketing, and in various other phases of specialized business activities.

The invention of new products is also an important factor. The great increase in the production of hi-fidelity and stereophonic record playing equipment, for example, has probably resulted more from the stimulation of a demand for these products than from any recent basic discoveries facilitating their production. Such new demands are, of course, real and legitimate and their discovery and development are just as productive and as significant for employment as the discovery and development of an ore deposit.

While some technological changes occur as a result of the emergence of a new idea, many others are primarily an adjustment by the firm to a change in economic conditions. Those may be changes in the size or nature of the market for a product, changes in the available supplies of productive resources such as labour, capital, material, power or transportation facilities, institutional or behavioural changes such as an increase in foreign competition, a change in government policy, or the merging of two or more plants with resulting relocations and rationalization of production.

There can be no doubt that technological changes make possible the creation of more and better goods and services, but they also create a set of problems for both society and the individuals comprising it.

Technological change often presents very difficult choices to the individual worker. Each alternative way of adjusting himself to an altered situation may involve hardship. Retraining necessitates considerable expenditure of time, money and energy. To move to locations where openings exist requires funds, and such a move may necessitate leaving friends and, perhaps, family behind. If a worker is strongly attached to the locality, he may prefer to take a job there at a lower skill level, with a corresponding loss of earnings and lowering of status.

The effect of technological change on various groups of workers is a differential one and is governed by a number of factors. The general level of economic activity, the extent to which the establishment that employs him shares in the prosperity or depression of the industry, the individual's age and seniority, and his occupation and skill are all important.

In times of expanding economic activity, it is considerably easier to make any adjustments that become necessary because of technological change. Provided the company shares in the general prosperity, an affected employee can be more readily transferred to other jobs in the establishment and seniority clauses in collective agreements offer a greater measure of protection.

During times of expansion in economic activity, the main burden of any changes in technology falls on potential jobs, that is, job opportunities do not expand as rapidly in the affected establishments as they would have with the older techniques. In this case, the most seriously affected group in the labour force is the new entrants, who may find it more difficult to enter the labour force in traditional occupational or industrial fields of employment.

In times of declining economic activity, again provided that the employing company is affected by the general trend in the industry, total employment not only fails to increase but often declines, with the result that layoffs become necessary. Because of seniority provisions in collective bargaining agreements, the impact of layoffs on plant workers will be greater in the case of the younger worker than the older worker.

Although seniority provisions, generally speaking, protect the older worker, it may occur that in one plant employees with several years of seniority are laid off, while at another plant which is expanding, new employees are hired

In no sector of the labour force, however, are adjustment problems greater than among the older workers. Older workers, by whom are meant in this context individuals approximately 40 years of age and over, have firmer roots in locality, usually more extensive family obligations, and a greater

investment in terms of time and effort in the job or skill which is displaced by the change in technique. Even when older workers are willing to make greater sacrifices, they may find age a barrier in obtaining jobs elsewhere and may not be flexible enough in outlook and ability to be retrained easily. In consequence, they may find it increasingly difficult to obtain alternative steady employment at comparable wages. In this case, hardships are imposed on their family and although willing they are able to contribute little to the welfare of the country.

While the various employment security clauses of collective agreements provide considerable protection for the older worker in general, they protect the younger worker less effectively. Because of this, younger workers as a group have somewhat different problems. Often displacement due to technological change affects them to a greater extent than the older worker, but in some ways they are better able to obtain alternative employment. They are more mobile, are less attached to locality and environment, have a smaller stake in the job or skill from which they are displaced, and, lastly, are usually preferred in hiring if other relevant factors are equal. Because of age, they may take advantage more readily of various company and public training schemes to improve themselves and learn skills which are in demand. That is not to say that problems associated with training the younger worker do not exist, but rather that adjustment to the changing demand for labour is relatively easier for them than for the older workers.

In the case of office workers, problems of adjustment again are different. Clerical workers are the group where displacement effects of technological changes may be greatest. As noted earlier, these workers at

present are primarily women, and their rate of job turnover is relatively high. This means that with some planning individual employers can avoid or reduce the need for layoffs by reducing hirings and allowing employment to decline through natural attrition.

This, however, does not solve the problem; it shifts it again to the young people who are just entering the labour force, or of course to those who are presently unemployed.

There is another aspect to this problem. The newer types of office mechanization--electronic computers--are making it possible for different kinds of office work to be integrated into one combined operation. This reduces the need for departmentalization of clerical and related work and thus may make many clerical supervisors, at the intermediate levels in the office hierarchy, redundant. These workers are frequently older people with many years of experience behind them, but only infrequently with the mathematical and technical aptitudes basic to the developing computer and related occupations. Here, then, is another area of potential displacement.

The relative decline in clerical supervisory jobs is also significant because it tends to narrow the promotional ladder for many other clerical people. This means that the younger clerical workers, if they stay in the labour market indefinitely, are faced with the prospect of either remaining at relatively low paying and routine clerical jobs, or making a considerable leap into semi-professional work in one of the expanding technical or staff specialist occupational fields. The latter kind of move is not an easy one to make without a good deal of education and specialized training.

It is clear then that some significant problems of adjustment have and are being created by the technological changes taking place in the Canadian economy. A common feature of many of them is the premium which they are putting on higher and higher levels of basic education and specialized training. Related to this is the growing importance for those now in school to understand in some effective way, not only the key facts about how the world of work is changing, but also some of the actual relationships between what they are studying and what they will be called on to do in their working lives. If young people cannot see, in more than abstract terms, how their studies today relate to their work and careers tomorrow, then they are left only too vulnerable for the empty attractions of an immediate job with an apparently steady income and not very demanding work. From the resulting school drop-outs will come the unskilled and semi-skilled unemployed of the future.

It should be emphasized that the research on which these comments are based is not yet complete. It needs to be extended in several directions. Not only are there areas where little or no research has yet been done, but also the situation is changing so much that some of the facts brought to light are already becoming obsolete. It is clear that systematic and reliable information about technological change and the various adjustments it generates needs to be assembled so that the manpower and training problems arising can continuously be evaluated and solutions sought.

Table 2

PERCENTAGE CHANGES IN THE AVERAGE EMPLOYMENT OF SELECTED OCCUPATIONS IN FIVE MANUFACTURING INDUSTRIES, BASED ON AVERAGE EMPLOYMENT FOR 1950-52 AND 1957-59

	I n d u s t r y				
	Electrical & Electronic	Household Appliance	Heavy Machinery	Automotive Parts	Auto- mobile
TOTAL EMPLOYMENT.....	+ 1 (13)	- 4 (12)	- 9 (13)	- 27 (8)	0 (6)
OFFICE EMPLOYMENT.....	+ 45 (12)	+ 28 (11)	+ 15 (13)	+ 34 (8)	+ 52 (6)
NON-OFFICE EMPLOYMENT.....	- 20 (13)	- 9 (12)	- 15 (13)	- 35 (8)	- 11 (6)
<u>Professional & Technical</u>					
Draftsmen.....	+ 38	+ 570	+ 39	+ 25	+ 14
<u>Clerical</u>					
Bookkeepers.....	+ 9	+ 47	+ 29	+ 36	+155
Bkkg. & Calculating M.O.'s..	- 15	+ 87	+ 72	- 31	+ 21
Key Punch & Tabulating M.O.'s (1).....	+ 13	+ 38		+ 69	+ 51
Secretaries.....	+ 8	+ 93	+ 52	+ 21	+ 46
Stenographers.....	+ 15	+ 15	+ 22	+ 4	+108
Typists & Clerk Typists.....	+ 21	+ 30	+ 19	+ 26	+ 12
Clerks nes.....	- 1	+ 6	+ 32	- 8	+ 12
<u>Maintenance</u>					
Carpenters.....	- 66	- 20	- 20	- 10	- 20
Tool & Die Makers.....	- 25	- 17	- 7	- 31	+ 40
Millwrights.....	+ 367		+ 5	+ 53	+ 33
Pipefitters.....	+ 675		+ 3	+ 13	+ 70
Welders.....	+ 13	+ 22		+ 84	+ 8
Mechanics.....	+ 122		+ 26	- 41	+ 76
Electricians.....	- 35	- 3	+ 24	- 10	+ 42
Stationary Engineers.....	+ 33	+ 6	+ 9		
<u>Production</u>					
Moulders, Machine.....			- 35	- 62	
Moulders, Floor & Bench.....			- 7	- 36	
Coremakers.....		- 76	- 33		
Chipper & Grinder Operators.			- 22		- 42
Fitters & Assemblers.....	+ 15	+ 26	+ 24	- 27	- 2
Machine Operators.....	- 23	+ 7	- 8	- 44	- 64
Sheet Metal Workers.....		+ 26	+ 8		+ 25
Boilermakers, Platers.....	0	- 35	- 67		
Welders, Prod.....		+ 4	- 11	- 41	+ 22
Polishers.....	- 25	+ 40			
Spray Painters.....	- 16	- 35	+ 25	- 75	- 6
Patternmakers.....		- 57	- 9		
Inspectors.....	- 3		+ 50	+ 65	+ 19
Power Truckers.....	- 2	+ 11	+147	+ 27	+ 74
<u>Labourers & Other</u>					
Labourers.....	- 54		- 41	- 51	
Truck Drivers.....	- 29		- 50	- 31	

Note: Figures in brackets indicate number of establishments covered.

(1) Employment figures for key punch and tabulating machine operators are based on 1953-55 and 1957-59 averages, since these occupations were not reported on prior to 1953.

